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"Technical Support for Grassroots Public Interest Groups"

July 2, 2014

Dennis McLerran <McLerran.dennis@Epamail.epa.gov>
Regional Administrator
US Environmental Protection Agency, Region 10
1200 6th Ave., Suite 900
Seattle, WA 98101-3140

Dear Mr. McLerran,

As you know, the Pebble Limited Partnership (PLP) recently submitted several documents to your agency which were intended to demonstrate that "no unacceptable adverse effects to aquatic resources would result from discharges associated with mining the Pebble deposit or that actions could be taken to prevent unacceptable adverse effect to waters from such mining."[1] The Center for Science in Public Participation (CSP2) has provided technical support, including geology, geochemistry, mining engineering, hydrology, and fisheries science, for groups concerned about the possible impacts associated with potential development of the Pebble deposit since 2007, and closely followed the development of EPA's Bristol Bay Watershed Assessment (BBWA). Consequently, after accessing PLP's documents from the Northern Dynasty Minerals website, we reviewed them and would like to offer you and relevant BBWA authors our independent feedback.

Many PLP comments relate to legal aspects of EPA's role in 404 permitting, which is outside our area of expertise. However, some PLP comments including Exhibit C (Authored by Ecofish), Exhibit D (Buell and Bailey), Exhibit E (Jason Quigley), Exhibit I (Knight-Piesold), and Exhibit J (Knight Piesold) relate to modern mining techniques and mitigation methods intended to minimize or offset impacts to aquatic resources. Our reviews pertain largely to those documents.

In general, PLP continues to make the argument that the mine described by Northern Dynasty Minerals[2] is hypothetical and not "permittable," though they fail to disclose any plan alternatives. Furthermore—as EPA has stated—mine development is constrained topographically, hydrologically, geologically, technologically, and economically due to the size, location, and type of the Pebble deposit. Consequently, while some details of the mine plan would change, impacts like those described in the Watershed Assessment are inevitable risks that would result from mine development.

To mitigate inevitable impacts, PLP describes a suite of methodologies which it argues can compensate for losses to Bristol Bay fisheries and freshwater habitat. By describing the numbers of mitigation projects executed and billions of dollars invested in the Pacific Northwest and British Columbia, PLP mistakenly assumes that work has solved the technological and biological problems at hand, in addition to all future, as yet indeterminate, problems. In fact, reviews of mitigation projects—including reviews cited by PLP's consultants—conclude that effectiveness of stream rehabilitation efforts are rarely measured at all; and when they are measured, projects frequently fail to meet their objectives.

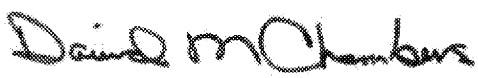
[1] http://www2.epa.gov/sites/production/files/2014-02/documents/bristol-bay-15day-letter-2-28-2014.pdf, p. 2. Accessed 30 June 2014.
[2] Ghaffari, H., R. S. Morrison, M. Andre de Ruijter, A. Zivkovic, T. Hantelmann, D. Ramsey, and S. Cowie. 2011. Preliminary Assessment of the Pebble Project, Southwest Alaska. Vancouver, British Columbia

For example, specific methods described by PLP and its consultants to restore salmon and salmon habitat have had variable, and only localized effects on impacted habitat in the Lower 48, where Pacific salmon remain at just 7% of historic levels (e.g., in-stream structure placement, stream fertilization). Methods described by PLP for so-called enhancement of natural systems are highly experimental, have had unintended consequences and mixed results, and have rarely—if ever—proven to increase recruits per salmon spawner (e.g., spawning channels, fishways, lake fertilization).

PLP's critique of the Watershed Assessment's analysis of potential tailings dam failures is based on the presumption that no such failure could possibly occur if a reputable engineering company and mining company are involved in construction and maintenance of a tailings dam, and the presupposition that any future problems are either minor in nature, or can be detected and solved before they would cause a failure. This sort of logic is exactly the type of presumptuous rationale that has led to past failures.

In general, CSP2 shares EPA's concerns about potential impacts to aquatic resources from development of the Pebble Mine, and finds many of PLP's comments disingenuous. We sincerely appreciate your efforts in this matter and hope you find the attached information useful.

Sincerely,



David M. Chambers, Ph.D., P. Geop.

Inc: (1) Comments on PLP Exhibit C (Ecofish Literature review of successes and efficacy of fish habitat restoration and compensation projects in British Columbia), O'Neal
(2) Comments on PLP Exhibit D (Buell & Bailey, Mitigation and EPA's Bristol Bay Watershed Assessment Final Assessment), Woody, CSP2
(3) Comments on PLP Exhibit E (Quigley Mitigation/Habitat Compensation Memo), O'Neal
(4) Comments on PLP Exhibit J (Knight Piesold mine facilities leachate memo), Zamzow, CSP2
(5) Comments on PLP Exhibit K (Knight Piesold Tailings Dam Failure Memo), Chambers, CSP2

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PLP Exhibit C – Ecofish Literature review of successes and efficacy of fish habitat restoration and compensation projects in British Columbia
(Comments by Sarah O'Neal, May 16, 2014)

Background

In response to EPA Region 10 Administrator, Dennis McLerran's announcement that EPA was initiating 404(c) review under the Clean Water Act, CEO Thomas Collier and Pebble Limited Partnership (PLP) submitted a letter that, in part, attempted to refute many of the extensively peer-reviewed, science-based conclusions EPA relied upon in coming to its decision. Among their arguments, PLP submitted a letter (Exhibit C) from an ecological consulting firm, Ecofish, which summarized the history of mitigation (or so-called habitat compensation) efforts in British Columbia (BC) and discussed what authors perceive as particularly successful mitigation techniques: 1) creating and restoring fish access to habitat, 2) spawning channels, 3) instream strucures, and 4) off-channel habitats, 5) lake and stream fertilization. This memo provides technical comments on the Ecofish contribution to PLP's response.

Contributors to fish habitat restoration in BC

Ecofish summarizes the history of mitigation projects in BC, including the provincial Salmon Enhancement Program (SEP), and Watershed Restoration Program (WRP). While authors tout the sheer number of projects completed as if they are a measure of success, they simultaneously report that projects "often do not involved detailed monitoring of salmon productivity and thus there is often **limited quantitative information** to evaluate projects success" in the case of SEP (p. 2, emphasis added) and "many of the projects have not implemented extensive monitoring programs" in the case WRP (p. 2). Authors go on to report how many hundreds of millions of dollars are invested in restoration, suggesting a correlation between financial investment and salmon productivity. Without quantitative monitoring programs, however, the success of restoration efforts and their cost-benefit analysis is unknown.

Types of restoration projects and efficacy of techniques for fish populations

Creating and restoring fish access to habitat

Although creating fishways is a common restoration tool in streams impacted by human disturbance, it is far less common in intact ecosystems such as Bristol Bay. Even then, fishway creation is still an evolving science with sparse data determining its effectiveness.[1] Ecofish states in its response memo that "most fishways have not been adequately assessed for fish passage" (p. 6). Furthermore, as EPA stated in its

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[1] Bunt, C. M., T. Castro-Santos, and A. Haro. 2012. Performance of fish passage structures at upstream barriers to migration. River Research and Applications 28:457-478.
Roscoe, D. W. and S. G. Hinch. 2010. Effectiveness monitoring of fish passage facilities: historical trends, geographic patterns and future directions. Fish and Fisheries **11**:12-33.
Williams, J. G., G. Armstrong, C. Katopodis, M. Larinier, and F. Travade. 2012. Thinking like a fish: A key ingredient for development of effective fish passage facilities at river obstructions. River Research and Applications **28**:407-417.

thorough examination of mitigation techniques, its ultimate effect on productivity of salmon and especially resident fish species is unpredictable:

> *Creating connectivity between parts of the river network that are naturally disconnected can have adverse ecological effects, including impacts to resident vertebrate and invertebrate communities, as well as disruptions to ecosystem processes. Introduction of fish to fish-less areas can lead to altered predator-prey interactions, food web changes, changes in algal production, nutrient cycling and meta-population dynamics of other vertebrate species. For example, previous studies on the introduction of trout species to montane, wilderness lakes have shown that introducing fish to fish-less lakes can have substantial impacts to nutrient cycles.*
>
> -EPA Final Bristol Bay Watershed Assessment, Appendix J, p. 17

Lastly, despite touting the benefits of fishways in its responses, PLP fails demonstrate its utility in Bristol Bay headwaters. In its Environmental Baseline Document, PLP described 145 'barriers' to fish migration.[2] Nearly half of those were beaver dams, which rarely serve as barriers to fish migration, and more often benefit juvenile salmon, as EPA describes in its final Assessment, and as is well described in the scientific literature.[3] The remaining 70 stream features are described as waterfalls, dry channels, cascades or barrier chutes, though definitions for what constitutes a barrier (i.e., barrier height, for which species, for which life stage, etc.) is never defined. Furthermore, the amount and quality of habitat upstream of those so-called barriers is not reported. Without additional detail from PLP, EPA can neither adequately characterize the extent of habitat fishways could provide for mitigation, nor predict the potential success of those efforts.

Spawning channels

As Ecofish points out, "[t]hese facilities have had varied efficacy, ranging from immediate and dramatic success...to relatively poor success" (p. 6), and as EPA noted in the Watershed Assessment, "there are very few studies regarding the efficacy of [spawning] channels at enhancing adult salmon recruitment in the published literature." [4] Consequently, the reasons for successes and failures have not been adequately identified, making their construction experimental. Furthermore, recent reports have highlighted the potential risk of increased production from spawning channels to existing wild stocks including: 1) possibly causing overharvest of less productive stocks thereby reducing genetic diversity and the portfolio effect responsible for overall sustainability,[5] 2) increasing disease outbreaks,[6] and 3)

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[2] PLP (Pebble Limited Partnership). 2012. Chapter 15: Fish and aquatic macroinvertebrates, Bristol Bay drainages. Pebble Limited Partnership Environmental Baseline Document: 2004-2008. Prepared by R2 Resource Consultants, HDR Alaska, Inc., EchoFish, Inter-Fluve, and Pacific Hydrologic, Inc. 6515 pp.

[3] Kemp, P. S., T. A. Worthington, T. E. L. Langford, A. R. J. Tree, and M. J. Gaywood. 2012. Qualitative and quantitative effects of reintroduced beavers on stream fish. Fish and Fisheries 13:158-181

[4] Appendix J, p. 23.

[5] Walters, C. J., J. A. Lichatowich, R. M. Peterman, and J. D. Reynolds. 2008. Report of the Skeena Independent Science Review Panel: A report to the Canadian Department of Fisheries and Oceans and the British Columbia Ministry of the Environment.

Schindler, D. E., R. Hilborn, B. Chasco, C. P. Boatright, T. P. Quinn, L. A. Rogers, and M. S. Webster. 2010. Population diversity and the portfolio effect in an exploited species. Nature 465:609-612.

[6] Mulcahy, D., J. Burke, R. Pascho, and C. K. Jenes. 1982. Pathogenesis of Infectious Hematopoietic Necrosis Virus in Adult Sockeye Salmon (Oncorhynchus nerka). Canadian Journal of Fisheries and Aquatic Sciences 39:1144-1149.

reducing average weights of smolts presumably because of competition at high juvenile densities.[7] Because of this uncertainty, several experts have called for further scientific assessments of potential risks of spawning channels.[8]

Instream structures

Like fishways, placement of instream structures has been widely used in degraded systems. However, studies evaluating the effectiveness of instream structure placement are sparse. And when effectiveness is evaluated,[9] studies are often inadequate, and generate mixed results.[10] Furthermore, quantitative evaluations have largely only documented effects on **local** salmonid density or biomass, as opposed to overall population effects, as mentioned by Ecofish (p. 8).[9] With respect to the placement of large wood, it is also worthwhile to note that studies of effectiveness have not taken place in regions dominated by tundra (and thus lacking readily available sources of wood), such as that of the Pebble deposit area. A recent study documents net exports of wood over time in streams without coniferous forest cover, suggesting wood placement would require perpetual maintenance.[11]

Off-channel habitats

Like other mitigation methods presented by Ecofish, information evaluating the effectiveness of created off-channel habitats is sparse. The review cited by Ecofish evaluated just seven off-channel restoration projects for one year, found **mixed results** regarding local population densities, and had no analysis of overall population impacts of off-channel restoration efforts to endangered Fraser Basin coho salmon.

Traxler, G. S., J. Richard, and T. E. McDonald. 1998. Ichthyophthirius multifiliis (Ich) Epizootics in Spawning Sockeye Salmon in British Columbia, Canada. Journal of Aquatic Animal Health 10:143-151.

[7] Peterman, R. M. 1982. Nonlinear Relation Between Smolts and Adults in Babine Lake Sockeye Salmon (Oncorhynchus nerka) and Implications for Other Salmon Populations. Canadian Journal of Fisheries and Aquatic Sciences 39:904-913.

Price, M. H. H. and B. M. Connors. 2014. Evaluating Relationships between Wild Skeena River Sockeye Salmon Productivity and the Abundance of Spawning Channel Enhanced Sockeye Smolts. PLoS ONE 9:e95718.

Wood, C. C. 2007. Managing biodiversity of Pacific salmon: Lessons from the Skeena River sockeye salmon fishery in British Columbia. American Fisheries Society Sylmposium 49:349-364.

[8] Walters, C. J., J. A. Lichatowich, R. M. Peterman, and J. D. Reynolds. 2008. Report of the Skeena Independent Science Review Panel: A report to the Canadian Department of Fisheries and Oceans and the British Columbia Ministry of the Environment.

Marine Stewardship Council. 2010. The British Columbia commercial sockeye salmon fisheries: final certification report Volume 1. Tavel Certification Inc., Dartmouth, Nova Scotia.

[9] Whiteway, S. L., P. M. Biron, A. Zimmermann, O. Venter, and J. W. A. Grant. 2010. Do in-stream restoration structures enhance salmonid abundance? A meta-analysis. Canadian Journal of Fisheries and Aquatic Sciences 67:831-84.

[10] Giannico, G. R. and S. G. Hinch. 2003. The effect of wood and temperature on juvenile coho salmon winter movement, growth, density and survival in side-channels. River Research and Applications 19:219-231.

[11] Jones, K. K., K. Anlauf-Dunn, P. S. Jacobsen, M. Strickland, L. Tennant, and S. E. Tippery. 2014. Effectiveness of instream wood treatments to restore stream complexity and winter rearing habitat for juvenile coho salmon. Transactions of the American Fisheries Society 143:334-345.

Lake and stream fertilization

Lake fertilization, though employed for decades, remains highly experimental and little evidence exists to support increased adult returns resulting from it. One review concludes that "that problems [with lake fertilization] are possible — even likely. This is not surprising. Freshwater food webs are relatively complex, and when entire lakes are fertilized to enhance the production and survival of anadromous sockeye, it is almost certain that unexpected results will emerge."[12] In some cases, increases in unwanted algae blooms or proliferation of inedible invertebrates have prompted researchers to adjust nutrient levels and to recognize that every lake will respond differently to treatment.[12,13]

Fertilization techniques are even less perfected in stream environments. Using fertilizer, nutrient analogs, or even salmon carcasses in streams fails to replicate natural salmon-derived nutrient subsidies in part because of the lack of physical disturbance spawning salmon cause.[14]

These methodologies were thoroughly discussed by EPA in their Watershed Assessment, which ultimately concluded:

> *There are still many gaps in understanding the role of nutrients in fish productivity, so there is a great deal we do not know about whether nutrient addition can be a successful method to increase fish productivity....manipulating stream chemistry in this largely unaltered ecosystem through the addition of N and P would be a challenging and difficult experiment with many negatives outcomes possible.*
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> -EPA Final Bristol Bay Watershed Assessment, Appendix J, p. 17

Conclusion

Ecofish concludes in its review that "[c]onsidering that few restoration and rehabilitation projects have taken...an ecosystem level approach to planning, it is not surprising that many projects have been unsuccessful" (pp. 11-12), and goes on to argue habitat "compensation ratios of greater than 2:1 should often be used" (p. 12). Currently, there is no compelling legal reason to employ an ecosystem level

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[12] Hyatt, K. D., D. J. McQueen, K. S. Shortreed, and D. P. Rankin. 2004. Sockeye salmon (Oncorhynchus nerka) nursery lake fertilization: Review and summary of results. Environmental Reviews 12:133-162.

[13] McQueen, D. J., K. D. Hyatt, D. P. Rankin, and C. J. Ramcharan. 2007. Changes in Algal Species Composition Affect Juvenile Sockeye Salmon Production at Woss Lake, British Columbia: A Lake Fertilization and Food Web Analysis. North American Journal of Fisheries Management **27**:369-386.

[14] Harvey, B. C. and M. A. Wilzbach. 2010. Carcass Addition Does Not Enhance Juvenile Salmonid Biomass, Growth, or Retention in Six Northwestern California Streams. North American Journal of Fisheries Management **30**:1445-1451.

Holtgrieve, G. W. and D. E. Schindler. 2010. Marine-derived nutrients, bioturbation, and ecosystem metabolism: reconsidering the role of salmon in streams. Ecology 92:373-385.

Shaff, C. D. and J. E. Compton. 2009. Differential Incorporation of Natural Spawners vs. Artificially Planted Salmon Carcasses in a Stream Food Web: Evidence from δ15N of Juvenile Coho Salmon. Fisheries **34**:62-72.

Tiegs, S., P. Levi, J. Rüegg, D. Chaloner, J. Tank, and G. Lamberti. 2011. Ecological Effects of Live Salmon Exceed Those of Carcasses During an Annual Spawning Migration. Ecosystems 14:598-614.

Verspoor, J., D. Braun, and J. Reynolds. 2010. Quantitative Links Between Pacific Salmon and Stream Periphyton. Ecosystems 13:1020-1034.

Wipfli, M. S., J. P. Hudson, J. P. Caouette, N. L. Mitchell, J. L. Lessard, R. A. Heintz, and D. T. Chaloner. 2010. Salmon Carcasses Increase Stream Productivity More than Inorganic Fertilizer Pellets: A Test on Multiple Trophic Levels in Streamside Experimental Channels. Transactions of the American Fisheries Society 139:824-839.

approach or compensation ratios greater than 1:1, and thus no reason to presume that would occur in the case of mitigating a Pebble or other large scale hardrock mine in Bristol Bay. Ecofish goes on to explain that expectations must be tempered that “restoration efforts can quickly mitigate watershed degradation” (p. 12), and “[t]he restoration of streams and rivers should also not be expected to offset widespread anthropogenic changes…” While those conclusions are reasonable, they may also equate with unacceptable adverse impacts from mining to the world-class Bristol Bay salmon fishery, even with extensive mitigation efforts.

Together, mitigation methods described by Ecofish amount to experimental attempts at manmade replication of productive salmon habitat. As evidenced by the hundreds of millions of dollars spent in the Columbia River Basin alone, and the failure to delist a single Columbia River salmon stock under the Endangered Species Act, it is clear that society has yet to achieve the ability to replicate or re-create natural salmon habitat and productivity, and in our attempts, we often compound salmon declines with unintended, often deleterious consequences. Furthermore, while local juvenile salmon densities may increase in response to specific restoration activities, it is ultimately adult returns (recruits per spawner) that determine success. Those numbers are rarely—if ever—reported in effectiveness evaluations of restoration activities. Existing, peer-reviewed literature reviews of restoration effectiveness virtually all conclude that the majority of restoration projects either 1) are never measured for effectiveness, or 2) do not meet their restoration objectives.[15]

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[15] Bernhardt, E. S., M. Palmer, J. Allan, G. Alexander, K. Barnas, S. Brooks, J. Carr, S. Clayton, C. Dahm, and J. Follstad-Shah. 2005. Synthesizing U. S. river restoration efforts. Science(Washington) 308:636-637.

Quigley, J. and D. Harper. 2006a. Compliance with Canada's Fisheries Act: A Field Audit of Habitat Compensation Projects. Environmental Management 37:336-350.

Quigley, J. and D. Harper. 2006b. Effectiveness of Fish Habitat Compensation in Canada in Achieving No Net Loss. Environmental Management 37:351-366.

Roni, P., T. J. Beechie, R. E. Bilby, F. E. Leonetti, M. M. Pollock, and G. R. Pess. 2002. A Review of Stream Restoration Techniques and a Hierarchical Strategy for Prioritizing Restoration in Pacific Northwest Watersheds. North American Journal of Fisheries Management 22:1-20.

Roni, P., K. Hanson, and T. Beechie. 2008. Global Review of the Physical and Biological Effectiveness of Stream Habitat Rehabilitation Techniques. North American Journal of Fisheries Management 28:856-890.

PLP Response to EPA's Bristol Bay Watershed Assessment
EXHIBIT D: Buell & Bailey, Mitigation and EPA's Bristol Bay Watershed Assessment Final Assessment
(Comments by Carol A. Woody, Ph.D., CSP2, 14 June 2014)

In their response to EPA's final Bristol Bay Watershed Assessment, Buell and Bailey highlight a "particular weakness" in EPA's assessment in failing to fully consider "feasibility and efficacy of compensatory mitigation for potential project impacts, particularly to the aquatic environment." In making their argument, Buell and Bailey rely heavily on their own prior EPA critiques. However, the majority of compensatory measures suggested in those prior critiques were clearly refuted by EPA (e.g. creation of ice fields, water pump-back systems, changing water chemistry, etc.). EPA refuted those measures logically because such systems have never been proven. Few supporting scientific studies exist for such techniques, and the very few studies that did evaluate those systems did not take place in Alaska or during Alaska's harsh winters.

In contrast to their own prior critiques, however, Buell and Bailey focus more on legal aspects of required mitigation under the Clean Water Act (CWA) namely: that mitigation for unavoidable impacts is permitted; it is required to offset losses; the US Army Corps of Engineers (ACOE), as opposed to EPA, determines if proposed compensatory mitigation is preferable and will be effective; and four categories of mitigation exist (restoration, establishment, enhancement, and preservation). Authors claim EPA ignored compensatory mitigation requirements in the assessment because in Appendix J, EPA describes the lack of impacted sites in the Bristol Bay watershed available to restore, enhance, or preserve fish or fish habitat in order to offset likely losses from mining. Authors suggest that this position by EPA "ignores decades of salmon and resident fish habitat enhancement projects in unimpaired rivers and streams … in California, the Pacific Northwest, British Columbia, and Alaska." In fact, Lower 48 populations are at less than 7% of historic levels[1] relative to Bristol Bay where they are at more than 100% of historic levels[2] indicating mitigation efforts are not as successful as authors suggest.

Buell and Bailey focus largely on the ongoing multi-billion dollar mitigation/ compensation program in the Columbia River intended to offset hydroelectric dam impacts to salmon and trout. However, despite providing in-text references, they provide no complete citations of peer-reviewed, scientific, quantitative monitoring studies to support their claims of successful mitigation/compensation. Citations are limited to weblinks to Columbia basin restoration budgets, program descriptions, amendments to previously established restoration plans. Studies described as successful in Bailey and Buell's comments (Table 2) were most commonly monitored for five years—an insufficient number of years to measure overall success. Three studies referenced monitored for only slightly more time (six years, nine years, and twelve years in one study of Atlantic salmon). Many of the examples authors describe as successful pertain

[1] Gresh, T., J. Lichatowich, and P. Schoonmaker. 2000. An estimation of historic and current levels of salmon production in the northeast Pacific ecosystem. Fisheries 25(1): 15-21.
[2] ADFG Division of Commercial Fisheries. 2013. 2014 Bristol Bay Sockeye Salmon Forecast. http://www.adfg.alaska.gov/static/applications/dcfnewsrelease/376901424.pdf

to species that do not occur in Bristol Bay (e.g., steelhead, cutthroat trout), and none pertain to sockeye salmon, Bristol Bay's most abundant and commercially valuable species. Furthermore, studies cited all took place in disparate ecoregions with warmer climates.

Bailey and Buell also refer to a Washington Department of Fish and Wildlife document providing guidance for habitat rehabilitation and enhancement, including techniques "suitable for unimpaired and non-degraded streams and riparian areas." They focus on re-connecting abandoned channels and oxbows to add "large amounts of high quality rearing, overwintering and spawning habitats," which they suggest would be ideal mitigation techniques in the Koktuli and parts of Upper Talarik Creek. They summarize numerous studies (which were difficult or impossible to locate given the lack of a complete list of citations) indicating that excavated habitats in alluvial floodplains where groundwater aquifers are near surface increase egg-to-emergence, egg-to-fry, and instream-overwinter survival rates, and increased density or carrying capacity of fry. Authors suggest EPA ignored this body of literature. However, authors cite no literature for later life stages (i.e., smolt outmigration/freshwater survival), including the ultimate measure of mitigation success: adult escapement. In doing so, Buell and Bailey are presuming that salmon are exposed to limitations of productivity only in early, freshwater life stages, without appropriate documentation to support their assumption.

PLP Exhibit E – Quigley Mitigation/Habitat Compensation Memo
(Comments by Sarah O'Neal, 16 May 2014)

Background

In response to EPA Region 10 Administrator, Dennis McLerran's announcement that EPA was initiating 404(c) review under the Clean Water Act, CEO Thomas Collier and Pebble Limited Partnership (PLP) submitted a letter that, in part, attempted to refute many of the extensively peer-reviewed, science-based conclusions EPA relied upon in coming to its decision. Among their arguments, PLP submitted a letter (Exhibit E) from one of its own employees (Dr. Jason Quigley with Hunter Dickinson) which countered his own peer-reviewed, published studies regarding the effectiveness of mitigation and habitat compensation in Canada. EPA relied on his previously published work because it is one of very few empirical reviews regarding the effectiveness of habitat restoration. The original work concludes that more than half of the projects evaluated did not meet their goal of no net habitat loss.[1,2] Despite his interpretation to the contrary in the letter, Dr. Quigley's original work remains valid for the purposes of EPA's evaluation of mitigation effectiveness.

Specific comments on memo text:

p. 1, para 3: Dr. Quigley characterizes successful mitigation (i.e., "habitat compensation") as exceptional, implicitly acknowledging that failure is more common.

p. 1, para 3: Dr. Quigley notes "...most of the aquatic habitat compensation projects in Canada studied did not fully achieve their enhancement objectives...primarily due to poor planning, insufficient funding and a lack of monitoring, maintenance and regulatory oversight."

This is another example of the need for a specific mine plan from Pebble Limited Partnership, including mitigation, in order to gain confidence in whatever mitigation strategies and essential follow-up monitoring and maintenance a plan would include.

p. 1, para 5: "The studies I conducted into the effectiveness of aquatic habitat enhancement projects in Canada did not conclude these programs were an ineffective means to compensate for the unavoidable effects of development activities on aquatic habitat."

In the abstract of one of the published studies to which he refers, Dr. Quigley and his co-author state, "approximately 63% of [habitat compensation/mitigation] projects resulted in **net losses** of habitat productivity" (emphasis added).[1] In his other paper, he summarizes, "67% of compensation projects resulted in **net losses** of habitat area" (emphasis added).[2] While he may not have concluded all mitigation programs were ineffective, his summary clearly states that more than half of the projects evaluated did not achieve their legally mandated objectives of no net less.

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[1] Quigley, J.T. and D.J. Harper. 2006. Effectiveness of fish habitat compensation in Canada in achieving no net loss. Environmental Management 37(3): 351-366.
[2] Quigley, J.T. and D.J. Harper. 2006. Compliance with Canada's Fisheries Act: A field audit of habitat compensation projects. Environmental Management 37(3): 336-350.

p. 2, para 2: "When compensation ratios were set at 2:1, fully 81% of projects studied achieved a net gain or no net loss in habitat productivity without any other improvements to compensation techniques or remedies to the administrative challenges observed."

Indeed, Dr. Quigley's original paper makes this conclusion, although it is stated differently: "We found that although success improved with artificial ratios of 2:1, **a substantial proportion of compensation projects still did not achieve [no net loss]**, a finding supported by others...Thus, even **if** projects were entirely compliant and created twice as much compensation habitat compared to the [harmful alteration, disruption, or destruction to fish habitat], the Habitat Policy goal of [no net loss] would **still** not always be achieved" (emphasis added). He goes on to state, "This is alarming," given Canada's required compensation ratios are in fact much lower than 2:1.[1] Indeed, given that U.S. no net less compensation ratios are also 1:1,[3] as opposed to the "artificial" 2:1 ratio, Dr. Quigley's conclusions suggest that a two-fold increase in regulatory protection could still fail to appropriately mitigate for 19% of Bristol Bay headwater losses. Given the extraordinary fisheries of Bristol Bay, even an unrealistically inflated 19% mitigation failure rate is unacceptable.

p. 2, para 3: "Ultimately regulators should require more than 1:1 replacement for aquatic habitat displaced by development activity – perhaps as high as 2:1. Additional ingredients for success include: a requirement for ongoing monitoring and maintenance; consideration of limiting factors and ecosystem constraints from a watershed context; and, importantly, effective regulatory oversight."

In his final conclusions in the original paper, Dr. Quigley not only states that even a 2:1 replacement ratio is not entirely effective at replacing or mitigating habitat as described above, he also states: "the focus on habitat quantity only may be flawed because we demonstrated that artificially increasing compensation areas to ratios of 2:1, by itself, was not sufficient to achieve a net gain in habitat productivity for all projects."[1]

Moreover, there is no indication that the mining industry in general, the State of Alaska, or the U.S. Federal government is taking steps toward increasing the current no net less objective of 1:1. Accordingly, EPA simply cannot rely on that assumption for the purposes of a present-day risk assessment.

Lastly, without a specific plan from PLP that includes intended mitigation techniques, it is impossible to evaluate whether mitigation efforts will include those ingredients reasonably recommended by Dr. Quigley (ongoing monitoring and maintenance, consideration of limiting factors and ecosystem constraints, and effective regulatory oversight). To date, PLP has failed to adequately characterize the ecosystem and thus its 'limiting factors and constraints' as evidenced by their inability to accurately enumerate salmon populations,[4] or quantify or characterize their habitat.[5] And relying on regulatory

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[3] Yocom, T.G. and R.L. Bernard. 2013. Mitigation of wetland impacts from large-scale hardrock mining in Bristol Bay watersheds. Seattle Journal of Environmental Law 3:71-100.

[4] Woody, C.A. 2012. Assessing Reliability of Pebble Limited Partnership's Salmon Escapement Studies. Fisheries Research & Consulting, Anchorage, AK. 25 pp.

O'Neal, S. 2012. A review of PLP Environmental Baseline Documents: Resident fish and juvenile salmon habitat, distribution, and assemblage. Fisheries Resea4rch & Consulting. Anchorage, AK. 21 pp.

oversight not only places the burden of regulation on Alaska taxpayers, but also (and perhaps because of that) has been limited to date. For example, PLP self-reported the only violations of water use permits they've been accused of to date. The State simply does not have the resources to constantly regulate such a remote area. [6]

p. 2, para 4: "Both institutional approaches and compensation science have evolved significantly over the past twenty years...and there are indications that rates of success continue to improve."

Dr. Quigley's mention of improved success of 'modern mitigation techniques' lacks a single example of such success. Few comprehensive reviews have been published since Dr. Quigley's. However, those that have largely concluded that monitoring data is insufficient to quantitatively evaluate the success of mitigation projects. One concludes, "despite locating more than 330 studies on effectiveness, as well as hundreds of other papers on rehabilitation, it was difficult to draw firm conclusions about many specific techniques because of the limited information provided on physical habitat, biota and costs, as well as the short duration and scope of most published evaluations."[7] Although the authors of this review cite some successes with "techniques such as riparian rehabilitation, road improvements (sediment reduction), dam removal, and restoration of natural flood regimes," they go on to state "**no long-term studies documenting their success have yet been published.**" (emphasis added).[7] And another concludes only 10% of ~3700 projects evaluated federally involved any form of assessment or monitoring with which to evaluate their success or lack thereof.[8] In general, comprehensive, quantitative information evaluating the effectiveness of global and US restoration efforts remains elusive. Consequently, relying on mitigation and restoration efforts in an ecosystem that currently supports the world's largest wild sockeye salmon fishery would be experimental at best.

Comments on Quigley's references

Dr. Quigley provides links to some of the work that he states reflect "positive changes" in fisheries management and habitat compensation in part as a result of his work cited by EPA. Those include:

1. 2012 Department of Fisheries and Oceans (Canadian Federal) amendments to the Fisheries Act, including an 'offsetting' (or habitat compensation) policy.

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[5] Parasiewicz, P. 2012. A review of PLP Environmental Baseline Documents: Instream and off-channel habitat distribution and modeling. Rushing Rivers Inc., Amherst, MA. 15pp.
Higman, B. 2012. Critique of Pebble Limited Partnership's Seismic Hazard Assessment. Ground Truth Trekking. Seldvovia, AK. 8 pp.
Stratus Consulting. Review of Pebble Limited Partnership's Environmental Baseline Document: Hydrologic characterization.
[6] http://www.adn.com/2010/02/12/1136582/pebble-mine-developers-to-pay.html
[7] Roni, P., K. Hanson, T. Beechie, G. Pess, M. Pollock, and D.M. Bartley. 2005. Habitat rehabilitation for inland fisheries: Global review of effectiveness and guidance for rehabilitation of freshwater ecosystems.
[8] Bernhardt, E. S., M. Palmer, J. Allan, G. Alexander, K. Barnas, S. Brooks, J. Carr, S. Clayton, C. Dahm, and J. Follstad-Shah. 2005. Synthesizing U. S. river restoration efforts. Science(Washington) 308:636-637.

2012 changes to the Canadian Fisheries Act have been widely criticized across political parties, with former fisheries ministers calling the new plan, "watered down, emasculated, and gutless," and indicating it shifted the responsibility of regulation from the federal government, to industrial developers. [9] The amendments generally narrow the Act's previous focus on fisheries *and their habitat* to fisheries protection alone, and decrease regulatory review and oversight under the questionable assumption that permitting times were negatively impacting economic growth.[10]

2. A series of government reports to which Dr. Quigley contributed which consist largely of guidelines and recommendations for creating monitoring programs.

   Of the four documents listed, none require monitoring under any legal framework, but simply define and provide suggestions for monitoring programs. Only one of the four documents include any empirical information regarding the effectiveness of habitat compensation projects, arriving at the same conclusions from Dr. Quigley's paper which were cited by EPA: "...in the majority of cases, the results showed that significant net losses of habitat productive capacity are likely occurring."[11] The paper goes on to list similar recommendations for monitoring discussed in the other three documents.

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[9] http://www.theglobeandmail.com/news/british-columbia/bc-politics/four-former-ministers-protest-taking-the-guts-out-of-fisheries-act/article2446031/; http://www.vancouversun.com/technology/Conservationists+scientists+fear+Fisheries+changes/6734721/story.html

[10] Tupper de Kerckhove, D., C. K. Minns, and B.J. Shuter. 2013. The length of environmental review in Canada under the Fisheries Act. Canadian Journal of Fisheries and Aquatic Sciences 70(4): 517-521.

[11] Quigley, J.T., Harper, D.J., and Galbraith, R.V. 2006. Fish habitat compensation to achieve no net loss: review of past practices and proposed future directions. Can. Tech. Rep. Fish. Aquat. Sci. 2632: vi + 22 p.

PLP Response to EPA Final Bristol Bay Watershed Assessment, with particular comments on PLP Exhibit J: Knight Piesold mine facilities leachate memo
(Comments by Kendra Zamzow, Ph.D., CSP2, 5 May 2014)

Background

In response to the announcement by Dennis McLerran, EPA Region 10 Administrator,that EPA was initiating 404(c) review under the Clean Water Act, CEO Thomas Collier and Pebble Limited Partnership (PLP) submitted a letter that, in part, attempted to refute many of the extensively peer-reviewed, science-based conclusions EPA relied upon in coming to its decision. This memo provides PLP statements in bold and our technical comments on PLP's statements in regular text. In particular this memo addresses Knight Piesold's comments regarding leachate from mine facilities (Exhibit J of PLP's letter). Reference to particular document numbers (Doc. #) refer to comments referenced in EPA's "Response to Public Comments on the April 2013 Draft of the Bristol Bay Assessment" available from: http://www.epa.gov/ncea/pdfs/bristolbay/EPAs%20Response%20to%20Public%20Comments_2ndERD_Apr2013.pdf. Italics are provided for direct quotes from EPA or other parties.

General Comments

In his letter, Mr. Collier asserts:

The Assessment evaluates mine scenarios largely of EPA's creation, which do not reflect modern mine engineering and environmental management practices. The Assessment's failure to consider modern mining practices led to numerous flaws in the Assessment, including:

- **Projected impacts on downstream water quality, water flows and aquatic habitat are greatly exaggerated** (p. 14).

The primary arguments are: that EPA overstated the amount of uncontrolled leachate that will flow from the waste rock pile (WR) and tailings facility (TSF) to waterways; that a large volume of uncontrolled leachate would not be permitted; and that escaped leachate would be detected through a modern monitoring system.

EPA has previously responded to these complaints. They base the risk assessment on mitigation measures that have been proposed (seepage cut off walls at 15% of the mine area and WR), and suggest they would be interested in seeing additional mitigation measures to reduce the risk. They also note that mitigation would be limited by hydrogeology: both the WR and TSF would be unlined facilities placed on permeable sand and gravel. Even should seepage recovery wells be placed closely together and run at high pumping rates, under these conditions and with a water table that is often at or near the surface, 100% of the leachate would not be captured.

It can be assumed that modern monitoring systems would be installed, but again there are foundational issues due to topography and hydrogeology. If the landscape allowed WR to be placed up-gradient of a TSF, and the TSF to be placed up gradient of the open pit – conditions that exist at Fort Knox and Donlin – escaped leachate would naturally flow to a detection-capture point. At a Pebble 6.0 scenario, WR would not be funneled, but indeed would straddle the divide between the Koktuli and Talarik (Nushagak and Kvichak) watersheds.

Lastly, although the total volume of leachate per year that EPA estimates could pass sample locations SK100F and UT100D appears large, it only represents 2-4% (up to a maximum of 9% at SK100F) of the total flow, and would not necessarily be detected, particularly if leachate moved out along several interconnected groundwater-surface water pathways.

They also argued that leachate quantity was estimated near the end of mine life. This is reasonable, as EPA needs to assess the risk of the material that will be on site forever. They provided the additional step of assessing the risk of mine build out in stages, by developing the Pebble 0.25 and Pebble 2.0 scenarios.

On a different topic related to water quality, water flow, and aquatic life: The importance of headwaters and the specific difficulty of restoring functional wetlands that would re-create the conditions that allow headwaters to form and function was not addressed at all by PLP, yet is a critical part of maintaining habitat during operations and restoring habitat post-closure.

Mr. Collier goes on to state that "**PLP has not yet defined a proposed development plan for the Pebble Project; accordingly, footprint impacts associated with the Assessment's mine scenarios are entirely speculative**" (p. 14).

This argument has been made before. EPA relies on an understanding of the location of the ore deposit, and topographical and economic constraints to facility locations. EPA's responses include (from response to AMA #2910 comments on second BBWA):

1) *The scenarios evaluated in the assessment are based on preliminary plans put forth by Northern Dynasty Minerals in Ghaffari et al. (2011), which are described as "permittable" and assume the use of modern conventional mining methods, technologies, and mitigation measures and compliance with current regulatory standards.*

2) *We based the locations of the pit, tailings impoundments, and waste rock piles on the plan put forth by Northern Dynasty Minerals in Ghaffari et al. (2011) and their own analysis of the site. The pit is necessarily located on the ore deposit. We believe it unlikely that the waste rock would be hauled away from the vicinity of the pit. The tailings impoundments were placed at locations that provided suitable topography without incurring the cost of very long pipelines and extensive support facilities.*

Review of Exhibit J

Exhibit J is a memo from Knight-Piesold to NDM regarding leachate from mine facilities; I reference "PLP" (the submitter) rather than Knight-Piesold (the memo author) in the discussion below.

<u>Introduction</u>

Assumptions that EPA made in developing the WR leachate scenario in the BBWA included:

1. WR leachate within drawdown cone would report to the pit during operations.
2. Of material outside the drawdown zone, 50% would be captured by seepage recovery wells while 50% would be un-captured. Because most of the WR would be within the drawdown zone, the un-captured leachate would represent about 18% of the total WR leachate and about 16% of the PAG leachate.
3. Seepage cut off walls would be installed around 15% of the mine area and WR area.
4. Proper design and mitigation could minimize seepage.

The key arguments put forward by PLP in Exhibit J, regarding the assessment of risk from contamination of water from uncaptured waste rock and tailings leachate were:

1. Scenario mines would not be permittable.
2. A mine that knowingly pollutes would be required to mitigate.
3. Current conventional leachate management and design technologies were ignored.

The memo concluded, "**the reported losses of waste rock and tailings leachate are substantially greater than what would be expected with current regulatory requirements and conventional seepage design considerations and management practices**" (Exhibit J, p. 1).

In short, EPA assessed the risk based on the information that was available. EPA and PLP agree the mine that was assessed was not permittable and would need additional mitigation measures; EPA requested further information on design, which PLP did not provide.

Requests and responses

During its development, EPA requested additional information from PLP that could have informed policy decisions based on the science-based Final BBWA. Unfortunately, PLP re-iterated arguments the EPA has already responded to, and did not provide additional useful information. Previous arguments and responses are highlighted below.

Arguments 1&2: Scenario mines would not be permittable; polluters would need to mitigate.

Previous comments and responses from the Second Draft of the BBWA:

a) Northern Dynasty Minerals Ltd. *(Doc. #3650)**:** 8.16 4. Seepage Rates would Never be Permitted: The 2013 draft BBWA assumes the seepage collection and pump-back system surrounding Pebble waste rock sites will only capture 50% of the water that contacts waste rock outside of the mine pit drawdown zone, with the balance being released to groundwater. Any design that achieves only 50% capture of seepage could not be permitted in Alaska or the United States* ***if it was shown that such a practice would allow water that exceeds water quality standards*** *to enter the environment.* (Emphasis added)

EPA responded: *This point is made in Section 8.2.4 of the assessment, which begins: "The high metal concentrations in the South Fork Koktuli River due to PAG waste rock leachate suggests that* ***mitigation measures should be considered beyond those described in this scenario*** *or the Northern Dynasty mining case (Ghaffari et al. 2011)." The assessment assumptions are based on the plan in Ghaffari et al. (2011) and our judgment of its likely efficiency. Complete capture of groundwater flows with wells in soils similar to the thick, highly permeable sand and gravel overburden at the site would require closely spaced wells and high pumping rates and would often result in losses between the wells. Ghaffari et al. (2011) show seepage cutoff walls around approximately 15% of the mine pit and waste rock pile perimeter.* (Emphasis added)

b) Council of Alaska Producers *(Doc. #4285), 1.7 The mine scenario in the revised Bristol Bay assessment could not be permitted under existing state or federal law.*

EPA responded: *We disagree with this comment. The scenarios evaluated in the revised assessment assume the use of modern conventional mining methods and technologies, largely as detailed by Northern Dynasty Minerals in Ghaffari et al. (2011). The assessment then evaluates likely unavoidable impacts resulting from the mine footprint and potential impacts that could result* ***if specific components of the mine—despite modern conventional methods and technologies—were to fail****.* (Emphasis added)

c) Pebble Limited Partnership *(Doc. #5536): Throughout the document, the Agency presumes a level of environmental performance by the mining industry that is entirely unsubstantiated and assumes a level of performance that would violate current State of Alaska and federal laws….. it is extremely unlikely that the three mine scenarios as presented in the Assessment would be able to obtain State, Federal, and local government permits…*

EPA responded: *The scenarios presented in the assessment are based largely on preliminary plans put forth by Northern Dynasty Minerals in Ghaffari et al. (2011), and assume that modern conventional mining practices and technologies are used. Proposed mitigation measures are those that could reasonably be expected to be proposed for a real mine in this area, and* ***are described as "permittable"*** *in Ghaffari et al. (2011).* (Emphasis added)

Argument 3: Current conventional leachate management and design technologies were ignored.

Previous comments and responses from the Second Draft of the BBWA:

a) Pebble Limited Partnership *(Doc. #5752): 2.27 The Assessment's failure to consider best mining practices and mitigation options is particularly egregious.*

EPA responded: *The scenarios presented in the assessment are based largely on preliminary plans put forth by Northern Dynasty Minerals in Ghaffari et al. (2011), and* ***assume that modern conventional mining practices and technologies are used.*** *Proposed mitigation measures are those that could reasonably be expected to be proposed for a real mine in this area, and are described as "permittable" in Ghaffari et al. (2011).* (Emphasis added)

b) Alaska Miners Association *(Doc. #2910): "EPA's mine omits prevention and mitigation strategies that Pebble would likely propose and that the government would certainly require"* And *"…the* ***location*** *selected for the EPA hypothetical mine, including tailings and waste rock,* ***is likely to impact significantly more anadromous fish stream habitat than other potential locations*** *in the Bristol Bay watershed."* (Emphasis added)

EPA responded: *The scenarios evaluated in the assessment are based on preliminary plans put forth by Northern Dynasty Minerals in Ghaffari et al. (2011), which are described as "permittable" and assume the use of modern conventional mining methods, technologies, and mitigation measures and compliance with current regulatory standards.*

And: *We based the locations of the pit, tailings impoundments, and waste rock piles on the plan put forth by Northern Dynasty Minerals in Ghaffari et al. (2011) and their own analysis of the site. The pit is necessarily located on the ore deposit. We believe it unlikely that the waste rock would be hauled away from the vicinity of the pit. The tailings impoundments were placed at* ***locations that provided suitable topography*** *without incurring the cost of very long pipelines and extensive support facilities.* (Emphasis added)

c) Northern Dynasty Minerals Ltd. *(Doc. #3650) 8.17 and 8.21 The statement that half (50%) of the leachate from waste rock outside of the leachate zone will escape and flow to surface waters is unsubstantiated. While the 2013 Assessment references the Wardrop (2011) (i.e., Ghaffari et al., 2011) report, it fails to include the discussion in the report where it is stated that a low permeability cutoff wall will be installed around the waste rock piles and extraction wells will be installed within the cutoff wall to capture water and leachate infiltrating below the waste rock piles. This* ***system can be optimized*** *by adding wells, increasing pumping rates, and/or installing cutoff walls deeper in order to achieve significantly more than 50% capture. In tandem with proper management of potentially acid generating (PAG) waste rock to maximize its placement within the drawdown zone, the capture of PAG waste rock leachate can be close to 100%.* (Emphasis added)

And: *8.16* ***Engineering solutions certainly exist*** *to achieve significantly greater than 50% seepage recovery at Pebble, including low permeability cutoff walls, groundwater extraction wells, and* *groundwater monitoring wells, particularly* ***given local bedrock conditions and its location in the upper reaches of several watersheds****. These engineering controls can be designed to achieve near full capture of groundwater within a target zone, and can be made more robust in areas where monitoring indicates that capture efficiency is not sufficient.* (Emphasis added)

EPA Response: *This comment is* ***consistent with statements in Section 8.2.4 that additional mitigation would be required****.* (Emphasis added, EPA response to comments p. 246)

And: *The comment provides* ***no evidence*** *that standard best engineering practices could achieve close to 100% leachate capture with the system described by Ghaffari et al. (2011),* ***particularly given the geology and hydrology*** *of the site.* (Emphasis added, EPA response to comments p. 250)

And: *Response to 6.62*: *Complete capture of groundwater flows with wells in soils similar to the thick, highly permeable sand and gravel overburden at the site requires closely spaced wells and high pumping rates and often results in losses between the wells. Ghaffari et al. (2011) show seepage cutoff walls around approximately 15% of the mine pit and waste rock pile perimeter. At the TSFs, Ghaffari et al. (2011) discuss seepage cutoff trenches along the toe of each embankment, but* ***no seepage cutoff or recovery wells along the remainder of the TSF perimeters*** (Emphasis added, EPA response to comments p. 137).

Discussion of permittability

PLP quoted the EPA statement: "**If waste rock piles are designed properly with appropriate mitigation measures, monitored and maintained, release of contaminants is possible, but unlikely**" (Exhibit J, p. 4).

However, the full sentence by the EPA reads: "*If waste rock piles are designed properly with appropriate mitigation measures, monitored and maintained, release of contaminants is possible, but unlikely*; ***however, accidents and failures causing contaminants to be transported may still occur***." (Emphasis added; Final BBWA, Appendix I, p. 5).

PLP also states that "*The predicted leachate flows in the EPA's assessment are higher than what would be acceptable under current regulatory standards…*" (Exhibit J, p. 3). However, their wording of this same comment in response to the Second BBWA was more accurate: "*Any design that achieves only 50% capture of seepage could not be permitted in Alaska or the United States* ***if it was shown that such a practice would allow water that exceeds water quality standards*** *to enter the environment*" (Doc. #3650)

The crux here is not the volume of leachate – which is not something that comes under permit review per se – but the effect on water quality. In daily operations, this would consist of wastewater treatment plant effluent and groundwater from dewatering wells (which might or might not be routed through the wastewater treatment plant) – each would be subject to a point-discharge permit. EPA, through their scientific analysis of risk, also identified non-point source leachate from WR and TSF as potential risks. The point was to identify possible risks in order to determine what types of mitigation might be prudent.

The EPA Final BBWA concluded that 99% (leachate) capture efficiency would be required in order to meet copper criteria for the South Fork Koktuli River under the Pebble 6.5 scenario, and that such efficiency would "*require technologies beyond those specified in ….the most recent preliminary mine plan*" (EPA Final BBWA, p. ES-15).

In fact, both NDM/PLP and EPA *agree* that the preliminary mine plan as put forward in the Wardrop report (2011) contained insufficient mitigation.

<u>Discussion of mitigation</u>

Throughout EPA's responses to comments in previous drafts of the BBWA, they have made it clear that they have identified risks that will require mitigation above and beyond what was outlined in the best-available material, the 2011 Wardrop report commissioned by NDM. In fact, they are asking: what will you do above and beyond installing cut-off walls on 15% of the area? They clearly stated that they believe mitigation will be constrained:

- Topographically (ore deposit; location to place waste material)
- Hydrologically (high water table; groundwater-surface water interaction)
- Geologically (permeable overburden)
- Economically (cost to haul waste rock; cost of liners)

Previously, they also suggested a flow analysis at the TSF would be useful: *"If a mine at the Pebble deposit goes forward, the design of the TSFs should include a more thorough flow analysis that would calculate the expected rate of flow and associated flow paths from the TSFs. If the calculated leakage rates were unsatisfactory from an environmental, operational, or economic perspective, the designer could incorporate other design elements (e.g., a liner) to reduce the expected leakage rate"* (EPA response to comments p. 167).

A clear and useful response from PLP might have been to provide a group of likely mitigation options complete with maps and calculations (for example, seepage detection well placements, groundwater levels, pumping rates, pipeline conveyance systems, and cost estimates plotted annually with production).

Instead, they provided a list of general technologies that industry uses (seepage collection ponds and cut-off walls, pumping wells to intercept leachate, liners, groundwater monitoring), but without any context as to how these technologies would function at a mine on the Pebble ore deposit. EPA also provided a list of mitigation options that industry uses in the Final BBWA. These included: liners, water diversion systems, waste rock segregation and blending, leachate collection systems/seepage drains, addition of low permeability materials to slow infiltration, and adding bactericides to waste. They noted limitations of each of the technologies, and concluded that, when done correctly and monitored, "*catastrophic consequences could be prevented*" (Appendix I, p. 6).

Mitigations suggested by PLP

- **Seepage collection ponds.** If PLP intends to place seepage collection ponds below TSFs and WR piles, they need to provide a map of the intended locations, including groundwater and surface water elevations to indicate that escaped leachate would realistically move towards the ponds in order for EPA to consider how this would lower ecological risk.
- **Pumping wells to intercept leachate.** The Final BBWA notes: *"likelihood that water would flow between wells and below their zones of interception in the relatively permeable overburden materials and upper bedrock. Wells would not catch all flows from the mine site given its geological complexity and the permeability of surficial layers."* (p. 8-13). A useful response from PLP would have been to provide maps of potential waste facility locations with the underlying geology and groundwater levels, and the route of groundwater and intercepted leachate from the WR area to the TSF or other destination. EPA also noted that wells would need to be spaced closely together and run at high pumping rates. PLP did not dispute this, but did not provide additional detail.

- **Seepage cut-off walls.** EPA assumes that 15% of the mine area and WR area would have cut-off walls. PLP did not provide details on whether they intended to cover a more extensive area.
- **Partial or full lining of facilities.** The Final BBWA notes that "Waste rock and overburden piles typically are not placed on lined foundations because of the cost and stability risk (Mining Minerals and Sustainable Development (MMSD) 2002), but rather are constructed on natural terrain; although the decision for lined or unlined piles is site-specific" (Appendix I, p. 3). A useful response from PLP would have addressed the issues of cost and stability for liner systems under 10 billion tons of waste rock and three world-class sized tailings facilities. Information on the life expectancy/ degradation and rippage risks of different types of liners available on the market would also have been useful; liners may continue to improve over time, but a risk assessment needs to consider the risk given current control options.
- **Groundwater monitoring program.** Effectiveness will be influenced by the underlying layer – permeable or impermeable – and by topography. These were not sufficiently addressed by PLP.

  PLP suggests that placing waste in the upper headwaters will facilitate mitigation controls. However, the volume of WR will almost certainly require it to straddle two watersheds (Nushagak and Kvichak or Nushagak and Chulitna), potentially multiplying the problem – uncaptured WR leachate from two watersheds cannot route to a single low point open pit during operations or post-closure. PLP provided no information on the effectiveness of monitoring, outside a single case study at the Fort Knox TSF. Unfortunately, the situation at Fort Knox differs from Pebble in several critical ways. The mine took advantage of topographical features that funneled any uncaptured leachate from WR into the TSF and uncaptured TSF leachate into a narrow valley where seepage detection wells could be placed. Pebble does not have this type of topography. Additionally, Fort Knox lies in a dry area; Pebble lies in an area where the water table is near or at the surface.

Per EPA's request for a flow analysis, PLP re-iterated EPA's statement but did not provide information.

Monitoring

Knight-Piesold further states that the volume of seepage EPA suggested could pass sites SK100F or UT100D would be easily detected (Exhibit J, p. 2). This is difficult to assess without knowing the normal range of flows at these sites. According to PLP's Environmental Baseline Documents, Chapter 7, Table 7.2-1 "Streamflow gaging station characteristics and results, 2004-2008", SK100F has a mean annual discharge of 28 cfs (12,540 gpm) and UT100D of 29.5 cfs (13,260 gpm). The table presented by Knight-Piesold, although listed in cubic meters per year, had the equivalent of 280-1,160 gpm of leachate passing SK100F and less than 550 gpm passing UT100D – that is, 2-4% of the mean annual flow, with a potential high of 9% of the flow at SK100F.

In fact, whether uncollected leachate could be detected after closure would highly depend on the relative volume of leachate to streamflow; during operations it would also be influenced by the volume of water that would be re-introduced to these locations from groundwater pumping during mining. PLP provided no information on what would be done if these flows were detected either during operations or during closure monitoring.

Discussion of common failures

In comments on the Second Draft of the BBWA, NDM commented, using a Geosyntac report:

8.18 Geosyntec Section: 3.1: *By presenting a "serious failure" that "allows untreated water to discharge directly to streams", the Assessment asserts this outcome as a "reasonable possibility", without any justification. Such an outcome, in reality is of extremely low probability as it would constitute direct violation of wastewater discharge regulations with severe penalties imposed. To call this a "reasonable probability" is a gross mischaracterization of wastewater treatment practices at modern mines. The Assessment is very misleading in that, taken as a whole, it leaves the reader with the impression that the long-term release of untreated waters and leachates are a certainty, even during routine operations* (EPA response to comments, p. 247).

EPA responded: *Failures that result in violation of permits do occur at mines and their frequency has not been "extremely low." The phrase "reasonable possibility" is not specific, but it certainly does not mean "a certainty even during routine operations"* (EPA response to comments, pp. 247-284).

An example from a modern mine might be illustrative. The Buckhorn mine in Washington state started operations in 2008 – that is, it is a "modern mine". Originally designed as an open pit, it was changed to an underground mine after negotiations with local groups. The website "Mining-technology" touted it: "*An extensive water management plan has been prepared and must be adhered to and contains clauses such as reusing groundwater to minimise usage. The mine also features a state-of- the-art water treatment facility.*" That is, it designed and installed modern, conventional mitigation technologies.

Although much smaller than Pebble (estimated 1545 Mt), and although designed to sequester waste behind cement in underground tunnels to prevent the type of WR leachate discussed in the BBWA, it has continually polluted water, struggling with "groundwater capture zone deficiencies" from 2009 on. In 2010, consultants suggested that they needed to increase dewatering and monitoring wells. In 2012, Buckhorn incurred a $395,000 fine for water pollution stemming from continued failure to capture mine water.

Summary

EPA assessed the risk to salmon-dependent ecosystems based on available information. The science-based analysis determined there were risks that would require additional mitigation. They did not ignore modern mine management and design, in fact they listed common types of mitigations with a discussion of limitations. They clearly stated that mitigation would be limited by topographic, geologic, hydrologic, and economic factors. In their April 2014 response, NDM provided no information that would indicate that EPA had made incorrect assumptions, and provided no information in sufficient detail to allow EPA to re-assess the risks they had identified.

- EPA assumed that WR would be placed on permeable material above bedrock; PLP did not deny this, nor did they indicate whether they could place WR above a natural clay or installed liner, install underdrains, or provide other mitigation. They suggested a groundwater monitoring plan without details.
- EPA assumed that mitigation would consist of partial cutoff walls. They provided a list of other possible options with a discussion of limitations. PLP provided a list of general seepage management strategies, but without any context as to whether they intended to use any or all of them and with no maps or calculations that could allow re-assessment of risk.
- EPA clearly stated what they would need to see a flow analysis from PLP; none was forthcoming.

The risk assessment stands firmly on the best available science, unless and until further relevant technical details are provided by the mining proponent.

PLP Exhibit K – Knight Piesold Tailings Dam Failure Memo
(Comments by David M Chambers, Ph.D., CSP2, 13 May 2014)

Summary of Key Findings:

(1) "*It is incorrect to imply that any particular proposed or actual dam structure is more or less likely to fail based solely on the extrapolation of general dam failure statistics that may not be representative of the dam structure in question.*"

Knight Piesold bases its argument on several unsupportable assumptions:

(a) That a rock-fill, centerline dam will be constructed at Pebble;

With regard to Pebble, Knight Piesold says in Exhibit K:

> *"... tailings dams with upstream construction are removed since this construction technique would not be used at the Pebble Project,"*

A rock-fill, centerline dam may be what the project starts with, but there is no assurance that a less-safe construction type would not be used later. All of the existing tailings dams in Alaska have been started as downstream-type. The Pebble dams would be centerline-type dam construction, which is not as fundamentally safe as downstream-type (which is more expensive), but is safer than upstream-type dam construction.

An Alaska example of how the presumption of maintaining the original type of dam construction can be wrong is the tailings dam at Fort Knox. This tailings dam was planned and constructed as a downstream-type dam. However, for the final dam raise was changed from a downstream-type raise to an upstream-type raise. Upstream-type construction is associated with the largest number of dam failures. It is also ironic that Knight Piesold was the engineering company hired to design the upstream raise at Fort Knox.

Neither the mine operator, the regulator, nor their engineering consultants can say what the final configuration of a dam or mine will be. Only time will tell.

(b) That it will be maintained by a diligent operator, presumably NDM's yet-to-acquired major partner. It is also implied that Knight Piesold will continue to be involved with oversight of the dam construction and maintenance.

A change in mine ownership, and corporate culture, is common in the mining industry. Again, an example from Alaska – The Greens Creek mine was permitted and operated by the Kennecott corporation, as subsidiary of RioTinto, one of largest mining companies in the world. Several years ago Kennecott sold its interest in Greens Creek to the Hecla Mining Company, a mid-sized company with a failed "modern mine" (Grouse Creek) and significant financial liabilities associated with its old mines (Grouse Creek, Lucky Friday, Bunker Hill smelter Superfund site).

In addition, even good operators with good regulatory oversight can make mistakes that cause potential catastrophic problems. Again, an example from Alaska – at the Nixon fork mine:

> *"(On) October 25, 2011, the staff decided to waive gage observation until spring melt because the gage was frozen in ice."*

Then,

> *"On March 9, 2012, mine personnel noticed evidence of overtopping of the dam."*

Although this overtopping of the dam turned out to be an event with only minor consequences, it could have been much worse. The incident was entirely human caused, but is the sort of thing is not supposed to happen if "regulatory oversight is strong."

(2) "*Regulatory Setting - The Pebble Project is located in a jurisdiction where the permitting requirements are thorough and the regulatory oversight is strong. … it is our opinion that the ADSP (Alaska Dam Safety Program) is a world-leading effort in dam safety management.*"

The Alaska dam classification system is designed primarily for water retention dams. Tailings dams are not specifically mentioned in the Alaska regulations, yet tailings dams are the largest dam structures in the state. Tailings dams typically fall into what is called category Class II dams – that is a dam that, if it failed, would cause no loss of life, although a significant danger to public health may exist.

As a Class II dam in Alaska a tailings dam is not required under regulations to use the largest possible earthquake as the dam design earthquake event. And if fact, the Alaska Dam Safety Program has not required any Alaska tailings dam to meet this requirement, although most mine operators understand the long-term risks of earthquake damage, and are voluntarily planning their dams to meet the design requirements of the largest possible earthquake.

In addition, Alaska regulations do not explicitly prohibit the construction/use of upstream-type tailings dams, the type of dam construction that is associated with most tailings dam failures. The Alaska Dam Safety Program has allowed upstream-type dam construction to be used for the final raise on the Fort Knox tailings dam.

If this regulatory oversight is what constitutes "*world-leading effort in dam safety management*" – i.e.,

- no explicit consideration of tailings dams in the regulations,
- allowing the most problematic dam-construction type to be used, and
- operator procedural mistakes that could have caused catastrophic failure of a dam,

then there should be a degree of concern about "modern engineering practices."

(3) "*By ignoring the state-of-the-practice, the BBWA report incorrectly concludes that the "worst case" scenario of dam failure is inevitable. It is wrong to expect that a tailings dam constructed and operated at the Pebble Project would fail to meet or exceed state-of-the-practice standards for engineering, construction, monitoring and operation.*"

(a) Knight Piesold criticizes EPA for overestimating the risk of tailings dam failure in its Watershed Assessment analysis, and goes even further to say that EPA "… concludes that … dam failure is inevitable."

EPA does not conclude that dam failure is inevitable. The BBWA is a risk assessment. As a risk assessment the authors must evaluate the potential impact of a worst case event. The worst case event for a tailings dam is a dam failure and the release of tailings. This is the scenario that EPA assumed and evaluated in the BBWA.

EPA was careful to lay out the basis for its assumptions, and to say:

> *"The historical frequencies of tailings dam failures presented above may be interpreted as an upper bound on the failure probability of a modern tailings dam. Morgenstern (2011), in reviewing data*

from Davies and Martin (2009), did not observe a substantial downward trend in failure rates over time. However, improvements in the understanding of dam behavior, dam design, construction techniques, construction quality control, dam monitoring, and dam safety assessment would be expected to reduce the probability of failure for dams designed, constructed, and operating using more modern or advanced engineering techniques." (Bristol Bay Assessment, USEPA, January 2014, p. 9-9)

Knight Piesold conducts its own analysis of the long-term risks of a dam failure at Pebble. It evaluates each of the major tailings dam failure modes, and concludes that there is essentially zero possibility of dam failure at Pebble due to (1) accidents; (2) upstream construction related failures; (3) foundation failures; (4) overtopping; (5) improper construction; (6) improper operations; and, (7) mine subsidence. {see Table 1 ICOLD (2001) Case Histories and Mitigation Measures}

Knight Piesold then summarizes by saying:

"It is our opinion that all of these failure mechanisms can be mitigated with proper investigation, design, construction, operations and maintenance, and oversight."

Knight Piesold is essentially saying that there is no possibility of tailings dam failure at Pebble, which is the other extreme from the "worst case" assumption. A risk assessment could not logically or legitimately assume "no possibility of failure" for a tailings dam, as is suggested by Knight Piesold.

Tailings Dam Failure Examples

Knight Piesold criticizes EPA for using examples of tailings dam failures that:

"*…are either not relevant to Pebble, or their failure modes can be readily mitigated through proper design, construction, operations and management.*"

One thing to note about the Baia Mare (2000) and Tennessee Valley Authority (2008) dams is that even though they were small, their failures resulted in significant damage. The Baia Mare dam was newly constructed, and failed because it was overwhelmed during a large storm. This was a "new" technology era tailings dam. The dam failure was obviously due to poor dam design (not enough freeboard to retain flood waters) and poor hydrology (the flood waters were obviously larger than predicted), there is nothing to say this couldn't happen again – and it probably will.

The TVA dam failure was a coal slimes waste pond. Knight Piesold notes that the TVA dam, which failed due to water infiltration around a pipe through the dam, was probably started in the 1950's. However, even though this was an old structure, the component that failed – a pipe through the dam that eventually allowed a path for seepage around the pipe – is a feature that is still common on tailings dams today.

The Stava dam failure (1985), which something like the TVA dam was due to water infiltrating the dam foundation, is instructive because the failure of the upper dam caused the otherwise unrelated failure of the lower dam. Perched tailings dam configurations are common for larger mines, and a scenario that could conceivably be employed at Pebble in the long-term.

Los Frailes Mine tailings dam failure, Seville, Spain, 1998, is perhaps the most instructive, and the most relevant to Pebble. Although smaller than the Pebble tailings dam would be, it is a rock-fill dam, downstream-type construction – the safest construction type. The dam was designed by a reputable engineering firm, and operated by a reputable mining company. The dam failed due to an unstable layer of lime-rich mudstone below the dam. The weight of the dam and tailings caused the dam to move and fail. In hindsight they should have known this layer of mudstone would cause dangerous instability, and even though there were signs of instability, major corrective action was not taken. With the rupture of the dam, approximately 2 million m^3 of pyrite sludge and another 4 million m^3 of acid water containing high concentrations of heavy metals (zinc, lead, arsenic, copper, antimony, thallium and cadmium) flowed into the Guadiamar River. A 62-kilometer long section of the river - ranging from 500 to 1000 m in width - was affected. A total area of 4,634 ha of land along the riverbed were impacted. Of the area affected by the accident, 2,656 ha were part of the Doñana Nature Park and 98 ha were within the Doñana National Park.

Knight Piesold suggests that since this dam failure, and the publication of subsequent studies of other dam failures, there will be no more failures of large downstream or centerline dams. And, if there is a failure, it would not be in Alaska because of the strong regulatory environment. They suggest there would be no dam failure at Pebble because of the diligence of the as-yet-to-be-named mine operator and their consultants. To predict that a dam failure at Pebble is "inevitable" (as Knight Piesold claims EPA has done even though they didn't), would not be correct. But to not evaluate the potential impacts of such a possibility, even though small, and to assert there could be no such failure, as Knight Piesold suggests, would be ignoring the mandate of a risk assessment.

Earthquake Survival "Successes" in Alaska, Chile, Peru

Knight Piesold cites several examples in Alaska, Chile, and Peru, where tailings dams survived large earthquakes. In all of these cases the dams were at least 100 miles from these large earthquakes.

In engineering a dam to withstand an earthquake, an analysis is done to determine which earthquake is most likely to cause enough movement of the dam to sustain critical damage. The most potentially damaging earthquake, the maximum credible earthquake, becomes the maximum design event, or the seismic event the dam is designed to withstand without sustaining breaching. The analysis basically comes down to an evaluation of the dam movement due to a very large earthquake located along a distant fault line, or a smaller earthquake located along a fault line close to the dam. In almost all cases it is the smaller but closer earthquake that would cause the most damage.

It is likely that in all these cases cited by Knight Piesold the maximum credible earthquake/maximum design event was not an earthquake located at this distance, but a smaller earthquake located 30 or less kilometers from the dam. However, we do not have enough information from Knight Piesold to determine whether this is the case, and Knight Piesold does not present enough information to state otherwise.

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